

**CLAIMS**

We claim:

1. An apparatus for expanding video graphics array (VGA) text  
5 characters horizontally to fill the screen of a flat panel display  
(FPD), comprising:

means for storing binary information related to a horizontal  
row of a text character block;

means responsive to a control signal for controlling whether  
10 to duplicate a prescribed bit of said binary information;

means for determining the background and foreground  
characteristics of the last column of said text character block;  
and

means for ensuring that said background and foreground  
15 characteristics are consistent with said prescribed bit of binary  
information.

2. The apparatus of claim 1, wherein said ensuring means comprises  
a logic gate.

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3. The apparatus of claim 1, wherein said storing means comprises  
a shift register.

4. The apparatus of claim 3, wherein said shift register  
25 comprises D flip-flops.

5. The apparatus of claim 1, wherein said background and foreground characteristics of said text character block are derived from an ASCII character code.

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6. An apparatus for expanding video graphics array (VGA) text characters vertically to fill the screen of a flat panel display (FPD):

an addressable video memory for storing binary information  
10 related to horizontal rows of text character blocks;

multiplexer means for selecting either an address within a block of video memory or the starting address of a new block of video memory, to be provided as the next input to said multiplexer means;

15 a register for storing an offset value to be used in determining the next memory address of said video memory to be accessed; and

means for duplicating, selectively, a prescribed bit of binary information accessed from said video memory, comprising  
20 means responsive to a control signal for first determining whether to add said offset value to the current memory address to obtain the next memory address to access or to maintain the current memory address and thereafter for performing said addition when appropriate, the output of said determining means being applied to  
25 address said memory means for accessing said binary information.

7. The apparatus of claim 6, wherein the output of said determining means is stored prior to accessing the block of video memory.

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8. An apparatus for expanding video graphics array (VGA) text characters both horizontally and vertically to fully fill the screen of a flat panel display (FPD), comprising:

a shift register for storing binary information related to a  
10 horizontal row of a text character block;

duplication means responsive to a control signal for controlling whether to duplicate a prescribed bit of said binary information;

decoder means for determining background and foreground  
15 characteristics of the last column of said text character block;

means for ensuring that said background and foreground characteristics are consistent with said prescribed bit of binary information,

addressable video memory means for storing binary information  
20 related to horizontal rows of text character blocks;

multiplexer means for selecting either an address within a block of video memory or the starting address of a new block of video memory storing bits of information to be duplicated, either type of said address being provided as input to said multiplexed  
25 means;

a register for storing an offset value to be used in determining the next memory address to be accessed; and

means for duplicating, selectively, bits of information for image expansion, comprising means for first determining whether to add said offset value to the current memory address to obtain the next memory address to be accessed or to maintain the current memory address for duplication and thereafter for performing said addition when appropriate, the output of said determining means being used to access said memory means for said binary

10 information.

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9. The apparatus of claim 8, wherein said ensuring means comprises a logic gate.

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15 10. The apparatus of claim 8, wherein said shift register comprises D flip-flops.

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11. The apparatus of claim 8, wherein said background and foreground characteristics of said text character block are  
20 derived from an ASCII character code.

12. A method for expanding video graphics array (VGA) text characters horizontally to fill the screen of a flat panel display (FPD), comprising the steps of:

25 storing binary information related to a horizontal row of a

text character block;

outputting said binary information serially from said register;

selecting a prescribed bit of said binary information;

5 twice duplicating said prescribed bit of binary information;

and

displaying in succession said prescribed and duplicated binary bits of information.

10 13. The method of claim 12, wherein said prescribed bit is the in the last column of a block of said binary information.

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a2 } 14. The method in claim 12, further comprising the steps of:  
decoding an ASCII character code of said text character to obtain  
15 a signal for determining whether the last column of said text character is of a background or foreground feature; and  
using said signal together with said prescribed bit in  
determining whether to duplicate the prescribed bit as a  
background or as a foreground feature.

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15. A method for vertically expanding video/graphics array (VGA) text characters to increase vertical screen resolution from 200 pixels to 600 pixels to fill the screen of a flat panel display (FPD), comprising the steps of:

25 twice duplicating a prescribed horizontal row of a character

block by twice accessing the same memory address to retrieve the stored binary information related to said prescribed horizontal row; and

5 displaying in succession said prescribed and duplicated horizontal rows.

16. A method for expanding video graphics array (VGA) text characters vertically to increase the vertical screen resolution from 350 pixels to 525 pixels or from 400 pixels to 600 pixels to  
10 fill the screen of a flat panel display (FPD), comprising the steps of:

duplicating prescribed alternate horizontal row of each text character block by multiply accessing alternate memory addresses to retrieve the stored binary information related to said  
15 prescribed horizontal rows; and

displaying said prescribed and duplicated horizontal rows.

17. A method for expanding video graphics array (VGA) text characters both horizontally and vertically to fill the screen of  
20 a flat panel display (FPD), comprising the steps of:

storing binary information related to a prescribed horizontal row of a text character block;

serially outputting said binary information from storage;

selecting a prescribed bit of said binary information;

25 multiply duplicating said prescribed bit of said binary

information;

multiply duplicating said prescribed horizontal row including  
said duplicated bits of said text character block; and  
displaying said prescribed and duplicated horizontal rows.

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18. The method in claim 17, further comprising the steps of:  
decoding an ASCII character code of said text character to  
obtain a signal for determining whether the last column of said  
text character is of a background or foreground feature; and  
10 using said signal together with said prescribed bit,  
determining whether to duplicate the prescribed bit as a  
background or foreground feature.

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19. The method of claim 18, wherein said prescribed bit is the  
15 last bit of a row.

20. A method for expanding video graphics array (VGA) text  
characters both horizontally and vertically to fill the screen of  
a flat panel display (FPD), comprising the steps of:

20 storing binary information related to a prescribed horizontal  
row of a text character block;  
outputting said binary information from storage;  
selecting a prescribed bit of said binary information;  
multiply duplicating said prescribed bit of said binary  
25 information;

duplicating once every other horizontal row, including any duplicated prescribed bits, of said text character block; and displaying said prescribed and duplicated horizontal rows.

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5 21. The method in claim 20, further comprising the steps of:  
decoding an ASCII character code of said text character to  
obtain a signal for determining whether the last column of said  
text character is of a background or foreground feature; and  
using said signal together with said prescribed bit,  
10 determining whether to duplicate the prescribed bit as a  
background or foreground feature.

15 22. An apparatus for vertically expanding video graphics array  
(VGA) graphics to fill the screen of a flat panel display (FPD),  
comprising:

memory means for storing binary information related to scan  
lines of graphics data, each of said scan lines being stored in an  
addressable memory location of said memory means;

20 multiplexer means for selecting either an address within, or  
the starting address of a new block of, a video memory having a  
content to be duplicated, said address within said block of video  
memory and said starting address of said new block of video memory  
being provided as the next input to said multiplexer;

25 register means for storing an offset value to be used in  
determining the next memory address to be accessed; and



means responsive to a control signal for first determining whether to add said offset value to the current memory address to obtain the next memory address to be accessed or maintain the current memory address for duplication and thereafter for performing said addition when appropriate, the output of said determining means being used to access said memory means for said binary information and form said address within said block of video memory.

23. The apparatus of claim 22, wherein said control signal commands said determining means to temporarily hold the memory address of every fourth scan line of the VGA graphics display to produce an additional cycle for duplication.

24. A method for expanding video graphics array (VGA) graphics vertically to fill the screen of a flat panel display (FPD), comprising the steps of:

duplicating every fourth scan line of the VGA graphics display by accessing the same memory address more than once to retrieve the stored binary information related to said scan line; and

displaying said scan lines and their duplications.

25. An apparatus for expanding video graphics array (VGA) graphics horizontally to fill the screen of a flat panel display

(FPD), comprising:

shift register means for storing binary information related to a prescribed horizontal row of graphics data; and

buffer means for first receiving binary information serially  
5 output from said shift register and, in response to a control signal, selectively duplicating said binary information.

26. The apparatus of said claim 25, wherein said control signal commands said buffer means to duplicate every fourth bit of said  
10 binary information.

~~14~~  
~~27~~. A method for expanding video graphics array (VGA) graphics horizontally to fill the screen of a flat panel display (FPD), comprising the steps of:

15 storing in a shift-register binary information related to a prescribed horizontal row of graphics pixels;

serially outputting said binary information from said register;

20 selecting regularly spaced, non-successive bits of said binary information;

duplicating selected bits of said binary information; and displaying said selected and duplicated horizontal rows.

~~15~~  
~~28~~. The method of claim ~~27~~, wherein said selected bits comprise  
25 every fourth bit of said binary information.

29. An apparatus for horizontally positioning a video graphics adapter (VGA) display image on the screen of a flat panel display (FPD), comprising:

5 first counter means for setting a horizontal FPD disable period associated with said FPD;

second counter means for setting a horizontal FPD enable period of said FPD, said horizontal FPD enable period being greater than a composite horizontal pixel time of a VGA image to  
10 be displayed;

first circuit means for controlling the start time of a subsequent horizontal FPD enable period, said start time being based on said horizontal FPD disable period;

second circuit means for controlling the end time of said  
15 subsequent horizontal FPD enable period, said end time being based on said horizontal FPD enable period; and

means for beginning said VGA display image based on said start time of said subsequent horizontal FPD enable period to locate said VGA display image at a desired horizontal position of  
20 said FPD screen.

30. The apparatus of claim 29 wherein said horizontal position is the horizontal center of said FPD screen.

25 31. A method for horizontally positioning a video graphics array

(VGA) display image on the screen of a flat panel display (FPD), comprising the steps of:

storing in a first storage circuit a horizontal disable period associated with said FPD;

5 storing in a second storage circuit a horizontal enable period associated with said FPD, said horizontal FPD enable period being greater than a composite horizontal pixel time of a VGA display; controlling the start time of a subsequent horizontal FPD enable period, said start time being based on said stored  
10 horizontal FPD disable period;

controlling the end time of said subsequent horizontal FPD enable period, said end time being based on said stored horizontal FPD enable period; and

starting said VGA display image based on said start time of  
15 said subsequent horizontal FPD enable period to locate said VGA display image at a desired horizontal position of said FPD screen.

32. The method of claim 31 wherein said desired horizontal position is the horizontal center of said FPD screen.

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33. An apparatus for vertically positioning a video graphics display (VGA) display image on the screen of a flat panel display (FPD), comprising:

first counter means for setting a vertical disable period  
25 associated with the FPD;

second counter means for setting a vertical enable period associated with the FPD;

first circuit means for controlling the start time of a subsequent vertical FPD enable period, said start time being based  
5 on said vertical FPD disable period;

second circuit means for controlling the end time of said subsequent vertical FPD enable period, said end time being based on said vertical FPD enable period; and

means for starting said VGA display image based on said start  
10 time of said subsequent vertical FPD enable period to locate said VGA display image at a desired vertical position of said FPD screen.

34. The apparatus of claim 33, wherein said desired vertical  
15 position is the vertical center of said FPD screen

35. A method for vertically positioning a video graphics array (VGA) display image on the screen of a flat panel display (FPD), comprising the steps of:

20 storing in a first storage circuit a vertical disable period associated with said FPD;

storing in a second storage circuit a vertical enable period associated with said FPD;

controlling the start time of a subsequent vertical FPD  
25 enable period, said start time being based on said stored vertical

FPD disable period;

controlling the end time of said subsequent vertical FPD enable period, said end time being based on said stored vertical FPD enable period; and

5 starting said VGA display image based on said start time of said subsequent vertical FPD enable period to locate said VGA display image at a desired vertical position of said FPD screen.

36. The method of claim 35 wherein said desired vertical position  
10 is the vertical center of said FPD screen.

37. An apparatus for horizontally and vertically positioning a visual graphics array (VGA) display image on the screen of a flat panel display (FPD), comprising:

15 first counter means for setting both horizontal and vertical disable periods associated with said FPD;

second counter means for setting both horizontal and vertical enable periods of said FPD, said horizontal FPD enable period being greater than a composite horizontal pixel time of a VGA  
20 image display;

first circuit means for controlling the start times of subsequent horizontal and vertical FPD enable periods, said start times of said subsequent horizontal and vertical FPD enable periods being based on said horizontal and vertical FPD disable  
25 periods;

second circuit means for controlling the end times of said subsequent horizontal and vertical FPD enable periods, said end times of said subsequent horizontal and vertical FPD enable periods being based on said horizontal and vertical FPD enable periods; and

means for starting said VGA display image based on said start times of said subsequent horizontal and vertical FPD enable periods to locate said VGA display at a desired position of said FPD screen.

38. The apparatus of claim 37 wherein said desired position is the horizontal and vertical center of said FPD screen.

39. A method for horizontally and vertically positioning a video graphics array (VGA) display image on the screen of a flat panel display (FPD), comprising the steps of:

setting horizontal and vertical disable periods associated with said FPD;

setting horizontal and vertical enable periods associated with said FPD, said horizontal FPD enable period being greater than a composite horizontal pixel time of a VGA image display;

controlling the start times of subsequent horizontal and vertical FPD enable periods, said start times of said subsequent horizontal and vertical FPD enable periods being based on said horizontal and vertical FPD disable periods, respectively;

controlling the end times of said subsequent horizontal and vertical FPD enable periods, said end times of said subsequent horizontal and vertical FPD enable periods being based on said horizontal and vertical FPD enable periods, respectively; and

5 starting said VGA display image based on said start times of said subsequent horizontal and vertical FPD enable periods to locate said VGA display image at a desired position of said FPD screen.

10 40. The method of claim 39 wherein said desired position is the horizontal and vertical center of said FPD screen.

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41. An apparatus for expanding video graphics array (VGA) text and graphics to at least partially fill the screen of a flat panel  
15 display (FPD), comprising:

a shift register for storing binary information related to a horizontal row of a text character block or graphics;

image expansion means responsive to a control signal for duplicating, selectively, a prescribed bit of said binary  
20 information within a prescribed horizontal row for horizontal expansion and for duplicating, selectively, said prescribed horizontal row including any duplicated bits for vertical expansion; and

displaying said prescribed and duplicated horizontal rows on  
25 said FPD.



<sup>17</sup>  
42. The apparatus of claim <sup>16</sup>41, wherein, for text expansion, the image expansion means comprises means for expanding text in both vertical and horizontal directions using different expansion  
5 algorithms, respectively.

<sup>18</sup>  
43. The apparatus of claim <sup>16</sup>41, wherein, for graphics expansion, the image expansion means comprises means for expanding a graphics image in both vertical and horizontal directions using a common  
10 expansion algorithm.

<sup>19</sup>  
44. The apparatus of claim <sup>16</sup>41, wherein said image expansion means carries out selective bit duplication for text and graphics image expansion.